

THE IMPACT OF THE INTERNET ON URBAN VITALITY:
DOES CLOSENESS IN CYBER-SPACE SUBSTITUTE FOR URBAN SPACE?

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Abstract

The rapid growth of the internet poses an interesting challenge for understanding how cities will grow in the future. Particularly, the advantage of the internet is that groups can be close, in terms of interactions, without being close in physical space. Thus the internet may substitute for urban areas, where people tolerate the increased congestion costs because of the advantages of proximity in physical space. On the other hand, it is equally possible that the internet merely increases the extent and scope of interactions, and that it is not yet capable of substituting for physical closeness. This paper compares the two possibilities, and then using data from US states shows empirically that urban areas increase the demand for internet access, suggesting the two are complements. Our work also suggests the complementarity may come more from the consumer side than the producer side.

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I. Introduction¹

The study of cities has, over the last two decades or so, accelerated as appreciation has grown for their advantages despite the disadvantages. The internet, however, poses an interesting challenge for thinking about the vitality of urban areas. In theory, the internet allows people to interact without being physically close, and thus on the surface seems like an ever-growing challenge to the existence of urban lifestyles. In addition to the ability to bring diverse people together- supposedly the clear advantage of urban areas- a serious additional advantage which the internet offers is an avoidance of the congestion that occurs in physical space. Thus it is logical to conclude that as the world becomes more electronically connected, the necessity to live in congested cities will fall, and people will instead begin to de-agglomerate and live in a more uniform distribution across the planet.

Conversely, however, the other alternative seems at least equally likely. By allowing communication without necessarily facing congestion costs, it may also be possible to use a city more fully. That is, if virtual communication is a complement to inter-personal interaction, then instead of replacing cities, the internet may serve to heighten the benefits while reducing the otherwise associated congestion costs. In this case, the internet will be a complement to urban areas, and the value of physical space will be enhanced by the availability of virtual space. People that study urban areas have

¹ The research reported in this paper benefitted from the physical interaction fostered by Peter Nijkamp, who provided an excellent creative forum in the conference he organized with Karima Kourtit at the International Tinbergen Institute Workshop, Amsterdam, May19-20, 2014,'Real People in Virtual Space.'

been aware of the challenge posed by internet at least since Gasper & Glaeser (1998). From this perspective, one of the great academic achievements has been to integrate the complexities of physical space into the academic understanding of cities. Now, an additional step will be required which is to integrate cyber-space into our understanding of cities.

For our look at this important question, we pose an interesting empirical question, which is whether there is a higher demand for the internet from urban areas, or from non-urban environments. Because urban forms are rather fixed for a period of time while internet demand is much more variable, we focus our examination on how various aspects of the urban environment affect internet demand. Further, by examining aggregate U.S. states rather than individual behavior, we can capture the combination of internet demand that comes from firms as well as individuals. The key features we examine include not only the level of urbanization within each state, but also whether the largest city in a state creates extra demand. Further, since an important attribute of urban environments is the creation of innovation, we add two variables to capture this aspect. Specifically, we examine the level of patents from each state, and we include the level of research and development expenditures (R&D) in each state from all sources including firms.

On the one hand, it can be imagined that urban residents should have the least interest in the internet, because they are already in such close proximity to both consumption choices, and contacts for productive requirements. Similarly, since rural residents are generally far from consumption opportunities as well as both complements and customers in production, they should have a much higher demand. Conversely, if

being in a city generates demand for contact with people throughout the world, we might expect that urban dwellers have the higher demand for internet connections. Similarly, it may be that those with a high demand for consumption variety will explore variety across the globe as well as within their physical environment, while those with low demand for variety need it neither in their physical space nor their virtual space.

A similar trade-off exists for firms, especially those that rely on innovation to maintain their presence. Higher R&D expenditures, as well as patent activity, may be stimulated by greater use of virtual space as these institutions will reach out anywhere to find an innovative edge. Conversely, it may be that physical contact and personal interaction are the best methods by which innovation is fostered.

To answer our question of the relative demand for virtual space compared to physical proximity, we examine the aggregate internet subscription behavior of residents and firms across U.S. states from 2000-2011. Specifically, consistent with the discussion above, this empirical research seeks to find whether residents and firms of urban areas are more or less likely to desire high speed internet access than those in non-urban areas. Further, in addition to a panel analysis of whether urbanization leads to more internet access, we separately examine whether larger cities have more or less internet access. Our hypothesis is that if city dwellers have sufficient personal interactions, there will be reduced demand for high speed internet access compared to rural residents, since rural residents will be looking for lower cost alternatives to an urban location. If the internet is an effective substitute for urban locations, those in rural locations will have very high internet demand. Conversely, it is possible that urban residency increases the demand for internet access, since it is possible that on-line activity enhances the urban experience.

Our empirical analysis finds that not only do urban populations demand more internet access, but when the urban population of a state is more concentrated in a single very large city, that internet access is even more important. We conclude from our analysis that virtual space is not a substitute for urban space, but that instead it complements urban activities.

We discuss the theoretical possibilities briefly in section 2 of this paper. Section 3 presents the annual data by state, as well as the specification of the empirical model. Section 4 shows the empirical results supporting that cities and the internet work together with the internet even more important for larger cities. Interestingly, we find that urban populations are more important than R&D expenditures at generating internet demand. A final section concludes by discussing how our empirical work is consistent with the bulk of the literature that addresses this question.

II. Model Discussion

Our discussion has been to consider the very real possibility that the internet could reduce the trend toward urbanization. Specifically, if the internet can create agglomeration benefits without physical contact, the necessity to co-locate may be much reduced. In such a case, the internet could substitute for cities and result in profound changes in the way people live as the tendency to disperse increases, consistent with the warning by Gilder (1995) as to the potential “death of cities” if internet communications were substitutes for face-to-face communications² In this case, that the internet could

² George Gilder, *Forbes ASAP*, February 27, 1995, quoted in Mitchell Moss(1998). Another popular phrase the “death of distance” was probably first used by Frances

substitute for cities may cause profound changes in the way that people live as the tendency to disperse increases. We discuss some research findings below that suggest some of the dimensions about which the internet substitutes for cities. Conversely, the alternative is that internet connectivity increases the benefits of being located within cities. Such benefits could occur because agglomeration benefits that result from physical proximity can be achieved more efficiently. Alternatively, a different pathway might be that the internet helps to mitigate congestion costs, thus reducing the costs of being in a city. We do not explore the pathway through which either increased benefits or reduced costs might occur, but we present below some research that speaks to these issues. Following the discussion that suggests both process may occur, we present some statistical evidence on whether urban living increases the share of the population using high speed internet connections. The reduced form result of the empirical test reinforces the suspicion raised by our review of the literature, which is that the net benefits of urban location may be increased by the internet, in which case the internet may accelerate the propensity for urban living.

A. The Internet as a Substitute for Urban Locations

One of the conundrums in urban economic research has been isolating the sources of agglomeration economies (Rosenthal and Strange, 2004). In this context, part of the discussion has been whether it is the interaction between firms which creates benefits, or instead whether it is the interaction between people. For example, one reason that the

Cairncross, a writer for the *Economist*, who later published a book with the same title in 1997 and revised in 2001.

internet may create a substitute for cities is potentially discussed by Lee and Rodríguez-Pose (2014). They discuss that what is important for creativity and innovation is creative occupations, rather than creative industries. In this context, it is easy to see that the internet may be effective at creating networks of professionals that do not necessarily live in proximity to each other. This is therefore the type of process by which the internet could substitute for urban proximity.

Another dimension by which the internet could substitute for cities depends on the process by which cities create innovation. For example, in a recent paper Neal (2014) discusses whether relationships depend on homophily or proximity. The distinction may be inadequate to fully describe whether the internet can substitute for cities, depending on in which dimensions it is that homophily matters. For example, if people desire sameness depending on physical characteristics, these can generally only be observed by proximity.³ On the other hand, if homophily is determined by intellectual characteristics, then the internet may be a perfect substitute for proximity.

B. Reasons why the Internet May Enhance Cities

Despite the validity of the processes discussed above, there are several strong reasons to believe the internet is not yet sufficient to reduce the net benefits of cities. One of the implications of considering the internet as a substitute for cities is that the role of transportation could be seriously diminished, even to the point where there is no impact of transportation on economic growth. That is, if physical space does not matter

³ Although perhaps as video conferencing technologies improve even this dimension could be replaced by virtual space.

for communication, an interesting question is whether physical space matters for trade, especially as real transport costs trend downward over time (Glaeser and Kohlhase, 2004). Given recent analyses showing the importance of transportation to economic growth, (e.g. Haynes and Chen, 2014), this would be a major change, and perhaps suggests that even if technology may eventually substitute for proximity, the internet by itself is not yet sufficiently advanced to do so.

There are other reasons that also suggest the internet is not yet reducing the demand for urban locations. Even though internet availability has become increasingly dense across the country, and indeed across the globe, one of the interesting features is that urban areas offer better and cheaper connections (Mack and Grubestic, 2014). Thus in our empirical work below we will estimate a reduced form model which discusses how urban populations impact the demand for the internet. If urban locations allow the internet to be less expensive, it suggests that the economies of scale in the city illustrate another potential societal gain of urban areas.

An additional point raised by Sohn, Kim and Hewings, (2003) is that the quality of the information technology pertaining to the internet is important. For example, they do a comparative study of Chicago compared to Seoul. They find that the internet contributed to agglomeration in Chicago, which suggests an important complementary role in urban benefits. On the other hand, they also find that the internet contributed to the dispersal of economic activity in Seoul. They speculate that the difference in outcomes is because the technology infrastructure was not strong enough to contribute to agglomeration in Seoul. Thus if the greater income generated in cities is invested in

information technology capital, it may be that cities can confer the benefits of the internet to themselves more quickly and completely than can rural areas.

Obren and Howell (2014) conduct a study that broadly corroborates the Sohn, Kim and Hewings (2003) finding, and reinforces that the conclusion with respect to Chicago may be more general. They conclude that the internet works better in cities, and that even national investment in fast broadband does not overcome the disadvantages of distance. Thus they believe the internet reinforces the function of urban areas.

The ability of cities to generate greater internet availability to themselves, which suggests even without direct evidence that its rate of return is higher, is consistent with evidence about usage of the internet. For example, Moss and Townsend (1997) find that internet use grew fastest in the largest US cities, although unevenly across different cities. Similarly, Grubestic (2014) finds that internet usage is much greater in urban compared to rural areas. While supply considerations may differ between urban areas, in general greater usage is consistent with the benefits to the users being greater.

Despite the faster growth rate in urban areas compared to others, however, it does not necessarily indicate that cities benefit from greater internet usage. Both Sinai and Waldfogel (2004) and Forman (2005) find that the internet and cities have some attributes that suggest both substitution and complementarity considering both individual and firm activities. Zhu (2012) finds, however, that the internet enhances urban life through telecommuting. As a caution, however, Kolko (2012) finds that the internet leads to larger cities as measured by population and employment, but not necessarily cities with higher incomes. This finding is in contrast to Czernich, Falck, Kretschmer, and Woessmann (2011) who find, using cross country data, that internet penetration leads

to higher economic growth. That this result is not aimed at cities, however, leaves as an open question whether cities benefit from higher internet usage. If competition between cities is available to all residents the larger resulting populations suggest greater total benefits even if the process leaves no evidence of marginal differences.

A final surprising result on a different dimension concerns social capital. While the link between social capital and economic well being is not firmly established, it is sometimes implied that cities need social capital to be effective. That is, because cities have higher congestion as well as denser living, if social capital is decreased then they may cease to be effective places to live. Bauernschuster, Falck, and Woessmann (2014), however, find that the internet leads to increases in social capital, not decreases, using an East German example. Based on the basic ideas sketched here, if the internet leads to an increase in social capital then it may lead to more effective cities, and thus suggests an alternative pathway by which the internet is a complement to urban living.

C. An Empirical Test

Based on the discussion above, both possibilities are clearly possible. We therefore empirically test whether or not internet demand is higher in urban areas. The premise of our empirical question is that non-urban residents will have a higher internet demand than residents in the city if they are using it to substitute for living in an urban area. Conversely, if urban residents have a higher propensity to subscribe to high speed internet connections, such behavior would suggest that internet usage complements urban living. These statements can only be true if we also control for other attributes of internet demand.

The data available to study this issue are by state, from 2000 through 2011. Thus we build a panel data set of U.S. states over time to explain the extent to which the population of a state is connected with high speed internet access. We explain internet connectivity with our urban variables, plus controls for income, education, the age structure of the population, race, and the industrial structure.

Specifically, the reduced form equation we estimate is:

$$\ln(C_{st}) = \alpha_1 + \beta_1 \ln(Urb_{st}) + \beta_2 \ln(BigCity_{st}) + \beta_3 Herf_{st} + \beta_4 RDExp_{st} + \beta_5 Pat_{st} + \sum_i \beta_i \ln(X_{st}^i) + \nu_s + \mu_t + \varepsilon_{st} \quad (1)$$

where C is the number of high speed internet connections in a state normalized by the population of state s in year t . Connectivity is explained in our specification by the share of a state's population that lives in urban areas, Urb , the share of the state's urban population that lives in the largest city, $BigCity$, a Herfindahl index of city size, $Herf$, the level of research and development expenditures per capita, $RDExp$, the number of patents per capita, Pat , and a vector of control variables for the age structure, education, income, race, and the structure of the labor market. The error term includes fixed effects for states and years.

Strictly, equation (1) is a reduced form. On average, however, the supply of internet services is expected to be quite elastic, and similar across states. That is, except for the regulatory structure in each state, captured here by our fixed effect terms, it seems unlikely that the cost of provision will vary substantially between states except to the extent the price is different in urban compared to rural areas (Mack and Grubestic, 2014). To the extent this assumption holds, our estimating equation can be interpreted as a demand equation. This distinction is relatively unimportant in this context, but it is

worthwhile noting that differences in connectivity between states over time is more likely to be coming from demand pressures than other factors.

III. Data to Estimate Interaction between Cities and the Internet

One way to examine how the extent to which the internet potentially substitutes for urban areas is to develop a test of internet demand in cities compared to other areas. We do this using panel data over U.S. states and years. There are four key variables to our specification; two reflect the urban environment and two reflect the environment for innovation.

The high speed internet connections data in this paper comes from the Federal Communications Commission (FCC). This data is available annually for the 50 US states over the period 2000-2011. The high speed connections data is defined as the sum of residential and business end user Internet access connections that are above 200 kilobits per second (kbps). In our high speed connections data, there are 7 missing observations since data reported for Hawaii and Wyoming starts in 2006 and 2001, respectively. In total, our state level panel data therefore contains 593 observations.

The data on our urbanization variables, such as the urbanization rate, is taken from the Census Bureau. In addition to the percent of the population living in urban areas, we construct two further variables. One is the share of the urban population contained in the largest city. We do this for two reasons. One is there may be non-linearity in the impact of urban population on internet connectivity. Second, it may be that the largest cities are qualitatively different in some way. An alternative we explore is to construct a Herfindahl index of city population, defined as the share of the urban

population in each city squared, summed for the state. The minimum city size for the index variable is 25,000 people. As is standard, a larger size of the index indicates the urban population is distributed in fewer larger cities rather than in many smaller ones.

Because both cities and the internet are tied to potential innovation, we collect two variables in an attempt to control for the business aspect of the urban environment as well as potential demand for internet connectivity. One is data on state level Research and Development (R&D) spending from the National Science Foundation (NSF), normalized by population.⁴ The second is the number of patents issued, which we also normalize by state population. The annual number of patents by state is obtained from the United States Patent and Trademark Office. This variable causes us to lose one more observation, because data for Missouri is missing for 2011. These variables are intended to capture potential innovation within a state since there may be a connection between both cities and the internet operating through innovation.

Demographic variables are obtained from the Census Bureau including the fraction of the population under the age of 18 years old, over 64 years old, and the share of the population that is white. The last variable leaves all other groups as the omitted variable. To control for the economic environment, we add the unemployment rate, and the share of the workforce employed in manufacturing. Both variables come from the Bureau of Labor Statistics (BLS). Income is captured by the per capita Gross State Product, provided by the Bureau of Economic Analysis (BEA). It is deflated using the Consumer Price Index from the BLS. Probably the most active sector for unions over the

⁴ The business R&D spending data was collected by the NSF from the Business Research and Development and Innovation Survey conducted jointly with the U.S. Census Bureau.

last two decades or so is the public sector (Hirsch, Macpherson, and Vroman, 2001). The public sector may impact internet connectivity in several ways, we test whether there is an impact using data from www.unionstats.com, which is a website developed by Barry Hirsch and David Macpherson. Finally, the education variables such as the fraction of the population with a college degree and the fraction with a high school degree are taken from the Current Population Survey.

Table 1 presents summary statistics for the 592 observations used in the regression analysis covering the 50 states over 12 years, less the losses for missing data. The first two columns of the table present the cross-state means for the first year of the sample, 2000. The next two columns present the cross state means for the last year, 2011, to illustrate the time dimension to our data. The final two columns present the summary statistics for the entire sample. The rapid growth in high speed internet connections is certainly apparent, although it might be surprising that even in 2011 almost a quarter of the population had no such connections. There is only a very slight trend in urban population, although it is interesting that the largest city in a state averages over 25% of the total urban population. The share at least suggests that the largest city is generally an important part of the entire urban experience in a state.

IV. Empirical Results

The purpose of testing the relationship described in equation (1) is to examine the impact of urban populations on internet connectivity. If the internet is able to replace cities, then we expect to see higher demand in non-urban places. Further, the largest cities should see the smallest demand, because those outside the city will use the internet

more heavily to substitute for services that are otherwise being provided by cities. On the other hand, if the internet is a complement to cities in that it allows people to more fully utilize urban services and/or the costs of congestion are reduced, then we should see higher propensity for internet connectivity in urban areas. Further, the largest cities should experience the highest connectivity.⁵

Table 2 presents the results for our empirical test, using our panel data of 50 states over the 12 year period 2000-2011. The variables are in natural logs, thus allowing the parameters to be read as elasticities.⁶ Four specifications are presented, where column (1) includes the full specification from equation (1). In column (2) we exclude the three urban variables, in column (3) we exclude solely the two innovation variables, and in column (4) we exclude solely the largest city variable.

The primary result is that high speed internet connections are very elastic to the degree of urbanization within a state. The coefficient of 3.37 suggests that for each 1% increase in the degree of urbanization that the number of high speed internet connections rises by 3.37%. The highly elastic result suggests that urban dwellers have a much higher interest in internet connections than do residents outside of the city. Consistent with the discussion above, we interpret this result to say that urban residents have a higher demand for connectivity than do rural residents, because most evidence suggests the price difference is quite small (Sinai and Waldfogel, 2004).

⁵ Our log specification should capture this effect, to the extent that exponential rises in congestion costs are reflected in exponential rises in internet demand.

⁶ The results are qualitatively unchanged with a linear specification, and the results are quantitatively similar at the means of the data.

The interpretation of the coefficient on urban population as being driven by demand is reinforced by the findings for the second variable in the table, the share of the urban population in the largest city. This coefficient is also positive and significantly different from zero, suggesting that if a larger share of the urban population is in the largest city, that internet demand is even higher. Larger cities are generally found to have both higher benefits to their populations than smaller cities, while also with higher costs (generally as a consequence of congestion). The empirical non-linearity greater than that found in the log specification of the urban population share is consistent with an interpretation of the internet as providing a complement to urban benefits. It is also possible that, to the extent the largest cities are associated with the most innovation, that innovation provides an additional component to the desire to be connected.

Based on the strength of the largest city variable, we additionally include a Herfindahl index of city size in the regression reported in column (1). The value of this variable is larger when the urban population is concentrated in fewer larger cities, and is smaller when the given urban population is spread over more different cities.⁷ The Herfindahl index, however, is not empirically found to have any independent effect, nor is it found to materially impact the coefficient on the largest city variable.⁸ That the Herfindahl variable is found to have no effect while the largest city variable is found to have a strong and consistent effect suggests it is the largest cities in which the internet is

⁷ This variable may be related to empirical city-size distributions such as Zipf's Law and the rank-size rule (Gabaix and Ioannides, 2004).

⁸ This result holds when the largest city variable is omitted from the regression as well, the other coefficients are unchanged and the t statistic on the Herfindahl index is less than one.

most important. This pair of results also consequentially suggests that the relative importance of the internet between small and medium sized cities is not very large.

The next two variables in the regression results in column (1) are meant to capture the importance of innovation to internet connectivity. We find, however, that R&D expenditures appear to have no impact on connectivity. Further, we find that the patent variable is actually negative and significant. In column (2) we exclude the three urban variables to see whether there is high collinearity. We find, however, that the two innovation variables, and indeed all the other coefficients of the regression, are unaffected by this omission.⁹ In column (3) we try a further experiment and omit the two innovation variables. Here we find that the only outcome is that the big city coefficient is attenuated and the relative standard error rises. Therefore, in column (4) we omit only the big city variable, and find there is virtually no change in any of the other estimated coefficients. Our conclusion from these experiments is that R&D generally has no impact on connectivity levels.¹⁰ The patent variable result may reflect industrial sector differences based on industries where patents are disproportionately important. It may be that cities where patents are more important are less likely to be concerned with connectivity, but we leave the effects of industrial differentiation to future research. Instead, we believe the R&D expenditure variable is more general to innovation efforts.

The other findings in the regression might be what is expected. States with larger minority populations are found to have lower internet connectivity. Higher

⁹ It is also true that excluding either of the innovation variables leaves all other coefficients unchanged.

¹⁰ To the extent the innovation variables are driven by firm behavior, the result of no effect may reflect that industrial demand is highly inelastic, all firms are just on the web.

unemployment is found to reduce internet connectivity, even though we do not see an impact from per capita income. There is no distinction found in connectivity due to the age structure of the population.

V. Summary and Conclusion

Our discussion of whether the internet will reduce the demand for urban areas shows several interesting possibilities. We investigate some of these possibilities empirically, by examining the interaction between urban areas and internet connectivity using a panel data set of U.S. states over the decade of the new century. The empirical work we present supports much of the literature that we have discussed in several interesting ways.

We argue in the Introduction that we need to analyze state level data to determine if urban areas increase the demand for internet access. We also argue that supply considerations are relatively unimportant, in which case our empirical work is an examination of demand. Conditional on these two statements, the strongest result in our empirical examination is that urban populations are found to create higher rates of high speed internet connectivity. This result appears quite robust to several alternative specifications, and as well is not only statistically significant but quantitatively large. While it seems unlikely that such results are a supply phenomenon, at this point it is only a maintained assumption. Nonetheless, we believe we have shown that urban dwellers are much more likely than others to desire high speed internet connections, and/or firms in urban areas are likely to require more high speed connectivity.

Further, and supportive of the interpretation above, the other intriguing result in our empirical examination is that the largest city in a state seems to generate separate forces outside of the underlying basic demand by urban residents. Our regression variable is the share of the urban population contained by the largest city in the state. This variable is found to generate greater internet connectivity even holding constant the overall rate of urbanization. We also show that this result is not an artifice of the overall structure of the urban population, in that a Herfindahl index based on city populations is found to be insignificant by itself, and found to be orthogonal to the large city variable. Given that congestion costs are generally found to be exponential, this result would be consistent with a result that the most important role of the internet is to control congestion costs.¹¹

Our discussion of the existing literature contains evidence about both the behavior of individuals, and the behavior of firms. Cities have been analyzed to show they are important to individuals for both consumption and employment. Cities have also been examined to show their importance to firms, which create employment and offer consumption choices. A more detailed research agenda could separately examine either individuals or firms to show where the internet could substitute for traditional urban activities and functions. In part, it is difficult to design such a detailed analysis because the profession still has an incomplete understanding of the causes of agglomeration economies (Rosenthal and Strange, 2004). For example, our analysis using aggregate R&D expenditures did not yield any results concerning connectivity. Nonetheless, our

¹¹ Clearly more research is needed to study the pathways by which the internet is useful to urban residents.

aggregate approach to this problem has shed important new evidence that the internet appears more likely to make cities more productive than the opposite.

We believe that our paper therefore presents strong evidence suggesting that the internet is an important complement to activities engendered by urban living. And, we believe that this result is actually consistent with much of the literature, even if this literature has not been previously pulled together. Whether the profession can use the introduction of the internet to finally distinguish the sources and causes of agglomeration benefits still remains on the profession's research agenda.

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Table 1: DATA MEANS

Variables	2000		2011		2000-2011	
	Mean	Std	Mean	Std	Mean	Std
High Speed Connections Per Capita	0.02	0.01	0.78	0.13	0.275	0.24
Urbanization rate	71.7	14.9	73.8	14.5	72.7	14.6
Share of Urban Pop in Largest City	28.2	17.1	27.2	17.1	27.6	17.0
Herfindahl Index of City Size	14.8	14.3	14.4	14.3	14.5	14.2
Patents per capita	0.0003	0.0002	0.0004	0.0003	0.0003	0.0002
Research and Development Expenditures (real 2011 \$)	924	737	1221	884	1085	817
%Public Sector Workers Unionized	33.6	17.9	33.7	18.8	33.3	17.8
Share of Workers in Manufacturing	12.7	4.8	8.9	3.4	10.4	4.1
Unemployment Rate	3.8	0.9	8.1	2	5.7	2.1
GSP per capita (real 2011 \$)	43,589	7,713	52,128	12,013	47,701	9,705
Poverty Rate	10.8	2.9	14.2	3.1	12.3	3.2
Share of pop under 18 years old	25.6	1.7	25.1	2.2	25.0	1.8
Share of pop over 64 years old	12.5	1.8	12.8	2	12.7	1.8
Share of pop white	76.0	12.8	77.6	16.2	75.6	15.5
Share of Pop with a College Degree	17.2	3.2	21.1	3.8	19.0	3.9
Share of Pop Completed H.S.	85.5	4.8	89.1	2.9	87.2	3.8

These are the panel means of the data for all 50 states from 2000-2011.

There are 592 observations in the last two columns.

TABLE 2: REGRESSION RESULTS OF INTERNET CONNECTIVITY

Variables	(1) ln (High Speed Connections Per Capita)	(2) ln (High Speed Connections Per Capita)	(3) ln (High Speed Connections Per Capita)	(4) ln (High Speed Connections Per Capita)
ln (Urbanization rate)	3.367** (1.671)		3.728** (1.588)	3.281** (1.644)
ln (Share of Urban Pop in Largest City)	0.624* (0.354)		0.430 (0.377)	
ln (Herfindahl Index of City Size)	0.219 (5.860)		1.369 (6.239)	4.439 (4.225)
ln (Patents per capita)	-0.369*** (0.127)	-0.379*** (0.122)		-0.356*** (0.129)
ln (R&D spending per capita) (in 2011 \$)	-0.018 (0.084)	0.021 (0.083)		-0.014 (0.085)
ln (%Public Sector Workers Unionized)	-0.084 (0.071)	-0.054 (0.078)	-0.085 (0.073)	-0.079 (0.071)
ln (% of Workers in Manufacturing)	0.551 (0.438)	0.532 (0.475)	0.486 (0.420)	0.439 (0.447)
ln (Unemployment Rate)	-0.317*** (0.114)	-0.343*** (0.113)	-0.345*** (0.117)	-0.305*** (0.116)
ln (Real GSP per capita) (in 2011 \$)	0.196 (0.310)	0.102 (0.319)	0.234 (0.317)	0.249 (0.305)
ln (Poverty Rate)	-0.029 (0.136)	-0.044 (0.135)	-0.048 (0.139)	-0.017 (0.133)
ln (% pop under 18 years)	-0.516 (0.371)	-0.479 (0.394)	-0.667* (0.382)	-0.491 (0.372)
ln (% pop over 64 years)	0.250 (0.586)	0.305 (0.561)	0.042 (0.531)	0.229 (0.587)
ln (% pop white)	1.572*** (0.285)	1.669*** (0.298)	1.240*** (0.279)	1.486*** (0.289)
ln (% Pop with a College Degree)	-0.223 (0.207)	-0.239 (0.208)	-0.298 (0.216)	-0.236 (0.208)
ln (% of Pop Completed High School)	0.438 (0.878)	0.526 (0.835)	0.606 (0.913)	0.246 (0.890)
Observations	592	592	593	592
R-squared	0.968	0.967	0.966	0.967

Robust standard errors in parentheses. Regressions include fixed effects for years, and states.

*** p<0.01, ** p<0.05, * p<0.1

Data includes all 50 states for the years 2000-2011.